Air Quality 101: Policy and Science, Focus on Maricopa County

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Maricopa County Brownbag

February 26, 2013

Maricopa County
Air Quality Department

CLEAN AIR : MAKE MORE

Overview

- The Clean Air Act
- Air Pollution Science
- Urban Haze
- Who Does What
- Three Decades of Progress

The Clean Air Act

- Health and welfare based National Ambient Air Quality Standards (NAAQS, see §109)
  - Primary - protect sensitive populations with ***an adequate margin of safety***
  - Secondary - protect plant and animal life, ecosystems, property, visibility, other welfare effects
  - Review of each NAAQS required every 5 years

Air Pollutants of Concern

- Carbon Monoxide
  - Robs blood of oxygen
- Ozone
  - A strong irritant that damages lung tissue
  - Damage to plants and wildlife; material damage
- Particulate Matter
  - Multiple health effects
  - Haze, damage to ecosystems, soiling
- Lead
  - Toxic

Air Pollutants of Concern

- Sulfur Dioxide
  - A strong irritant that damages lung tissue
  - Damage to plants and wildlife; material damage
  - Forms secondary particulate, acid precipitation
- Nitrogen Dioxide
  - A strong irritant that damages lung tissue
  - Damage to plants and wildlife; material damage
  - Forms ozone, secondary particulate, acid precip.
- Hazardous Air Pollutants
  - Intoxicants, carcinogens, other health effects

NAAQS Changes –

The Ever Lowering Bar

- Lead – 2008
- NO_2 – 2010 primary & 2011 secondary
- Ozone ratcheted down in increments: 1997, 2008 and 2013(?)
- Particulate Matter
  - PM_{10} – New in 1987, changed in 1997
  - $PM_{2.5}$ – New in 1997, changed in 2006 & 2012
- SO_2 – 2010 primary & 2011 secondary
- Monitoring changes
  - Methods – PM and Lead
  - Network requirements – CO, NO_2 & PM

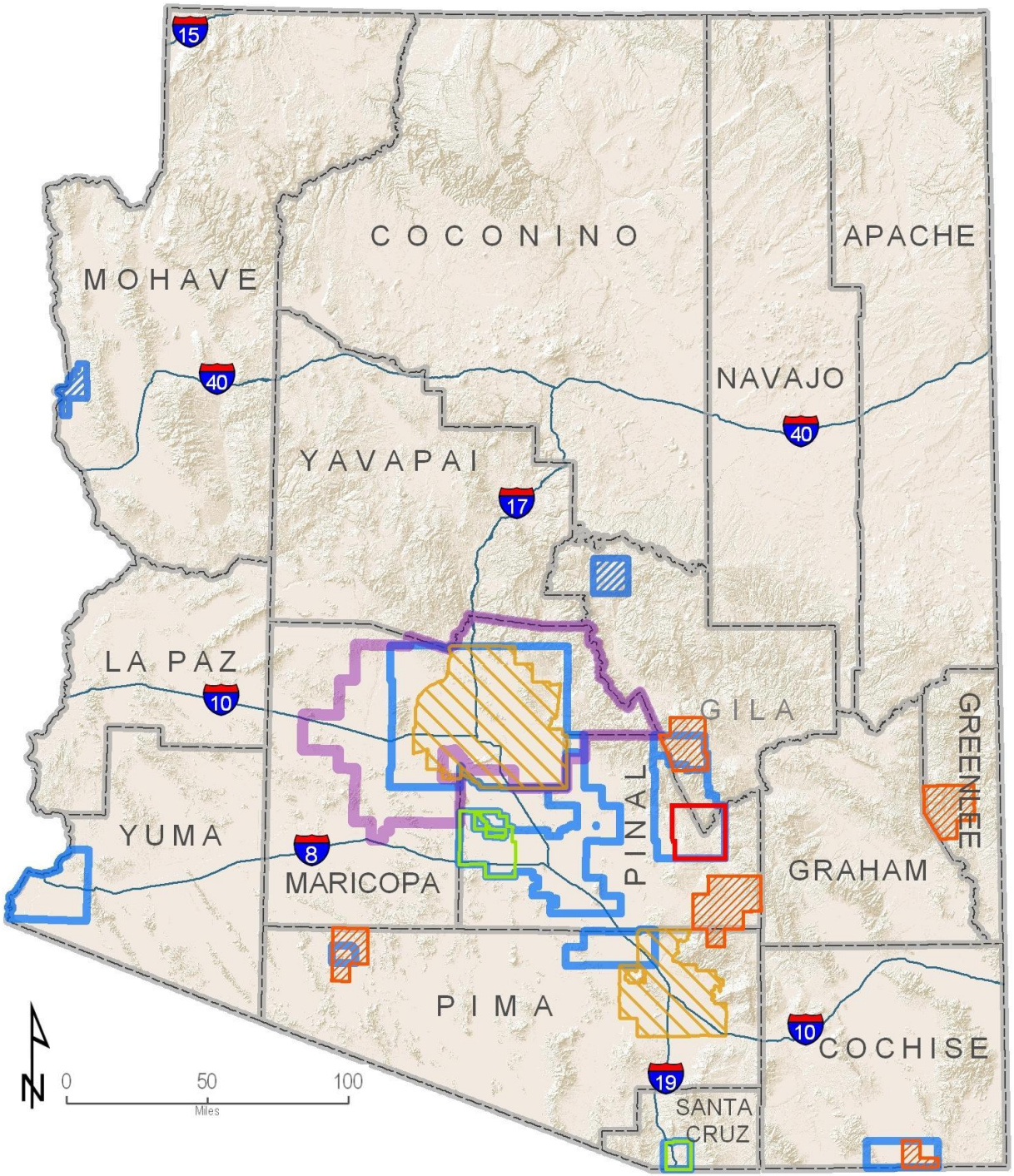
The Clean Air Act

- Air Quality Based Area Designations (§107)
  - Nonattainment Areas - do not comply with with NAAQS
  - Attainment Areas
    - Class I, II and III
    - Air Quality Control Regions
- National Visibility Program (§169)

Nonattainment Areas

- Carbon Monoxide
  - Tucson redesignated attainment in 2000
  - Phoenix redesignated in 2005
- Ozone – Phoenix, status changes
- Particulate Matter
  - 12 PM_{10} - all in attainment except, Nogales, Phoenix and Pinal County areas; 2 areas redesignated
  - Nogales and a portion of Pinal County nonattainment for $PM_{2.5}$
- 6 Sulfur Dioxide - no violations for many years; all but 1 areas are redesignated

ARIZONA NONATTAINMENT AND MAINTENANCE AREAS



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The Clean Air Act

- National Emissions Standards
  - Engines and Fuels (Title II)
  - Industrial Sources
    - "Conventional" Pollutants (§111)
    - Hazardous Air Pollutants (§112)
- Acid Rain (Title IV)
- Stratospheric Ozone Protection (Title VI)

The Clean Air Act

- New Industrial Source Permitting
  - Major Sources
    - New Source Review in nonattainment areas - Lowest Achievable Emissions Rate (LAER)
    - Prevention of Significant Deterioration in Attainment Areas - Best Available Control Technology (BACT)
  - Minor Sources

The Clean Air Act

- Bringing Nonattainment Areas into Attainment (Title I, Subparts 3 and 4)
  - Nonattainment Area Plans
    - Ambient Monitoring
    - Emissions Inventories
    - Air Quality Modeling
    - Pollution Control Programs - some required by CAA, plus others as necessary for attainment
    - Transportation and General Conformity
  - Maintenance Plans

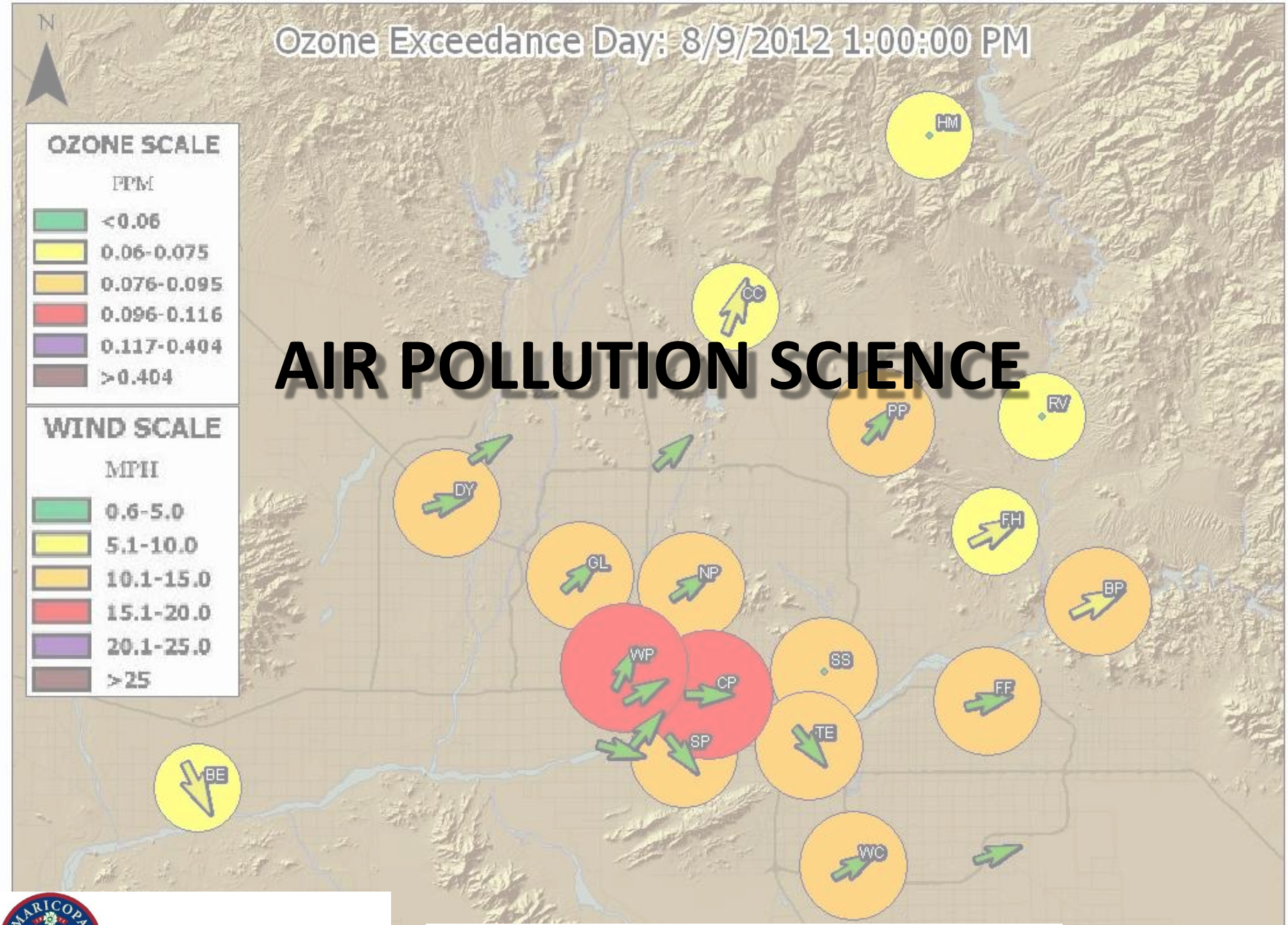
The Clean Air Act

- Grants to States, Tribes and local air pollution control districts (§105)
- Standards for State and Tribal air quality programs (§110)
  - State and Tribal Implementation Plans (SIPs, including local programs, and TIPs)
  - Sanctions if a state does not comply
  - Federal Implementation Plan (FIP)

The Clean Air Act

Other Major Provisions

- Operating Permits for Major Industrial Sources - Title V
- Enforcement (Title III)
- Citizens Suits (§304)



AIR POLLUTION SCIENCE

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Consider the Source

- What are they?
  - Mobile Sources - on & off road
  - Industrial activities (point sources)
  - “Area” Sources
  - Natural Sources
  - Transport of pollution from other areas
- Most important factors are location, quantity and time of day
- Generally, emissions change little day to day

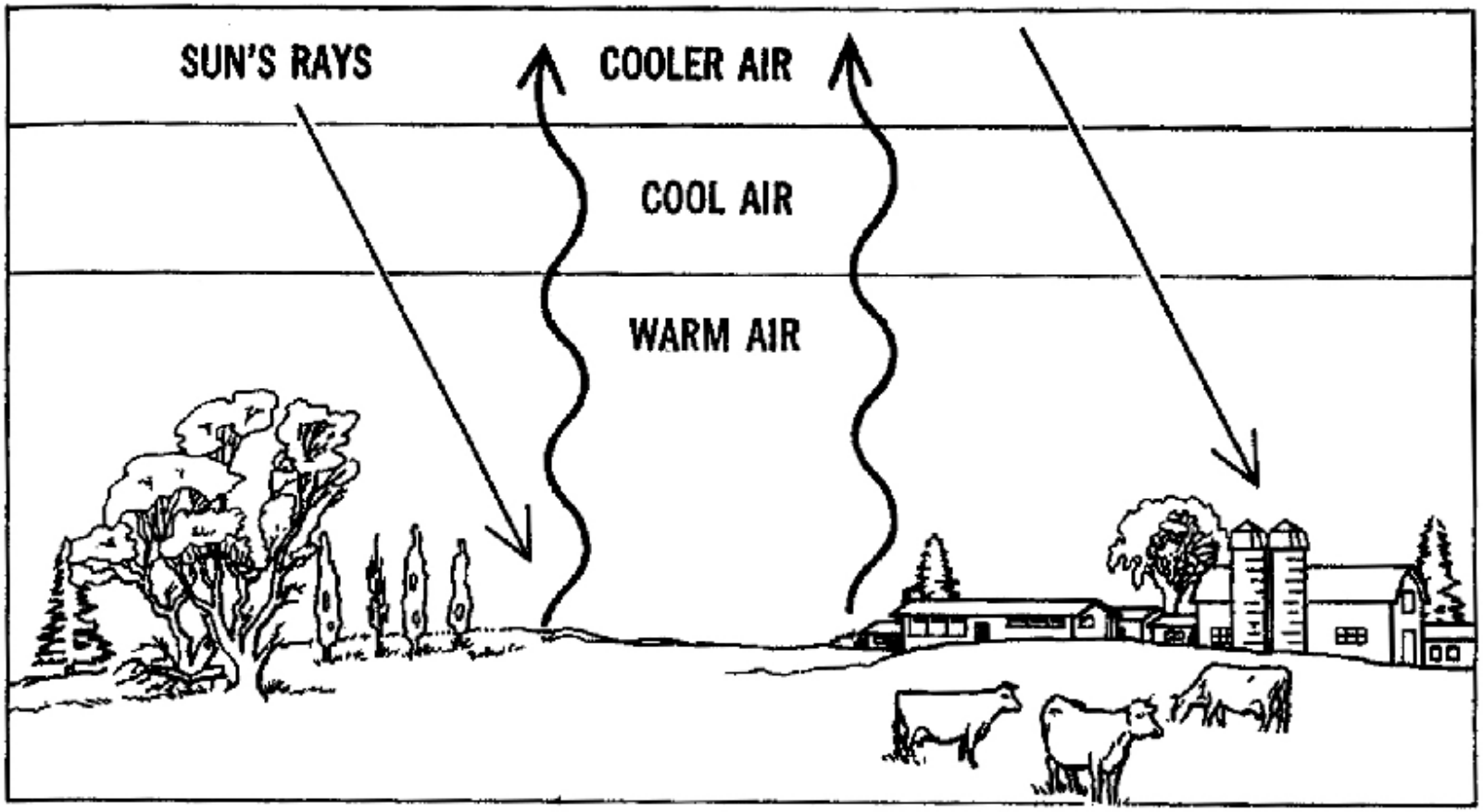
Environmental Factors

- Weather and geography are the most important influences:
  - Atmospheric stability
    - Phoenix area has lowest average wind speeds of major metro areas in U.S.
  - Topography
    - Broad alluvial basin, surrounded by small mountain ranges

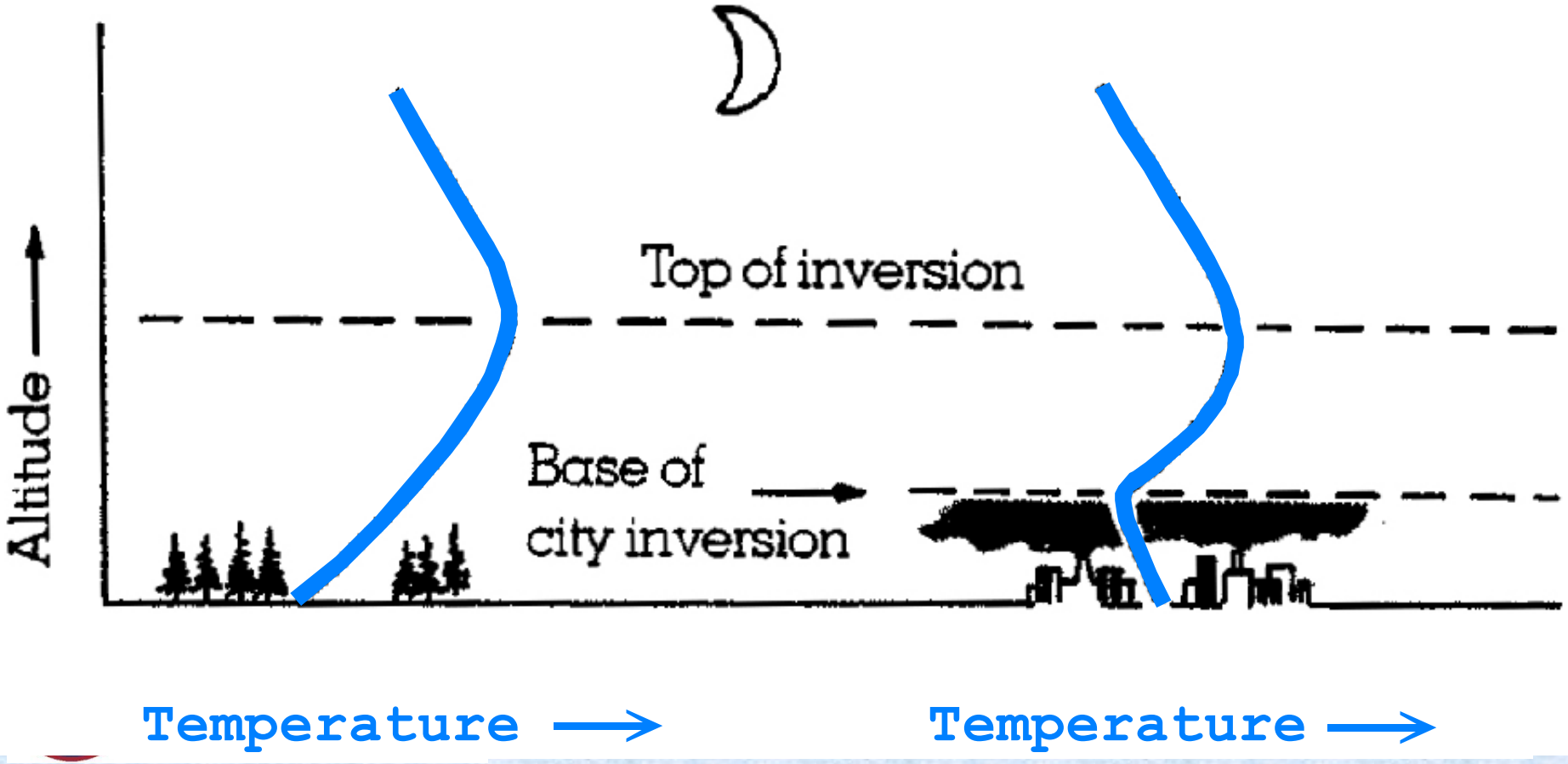
Atmospheric Physics

- Atmospheric Stability:
  - High Wind Conditions
  - Unstable Conditions
  - Stagnant Air - Temperature Inversion

Under “normal” conditions, temperature decreases with elevation; warm air rises and mixing occurs



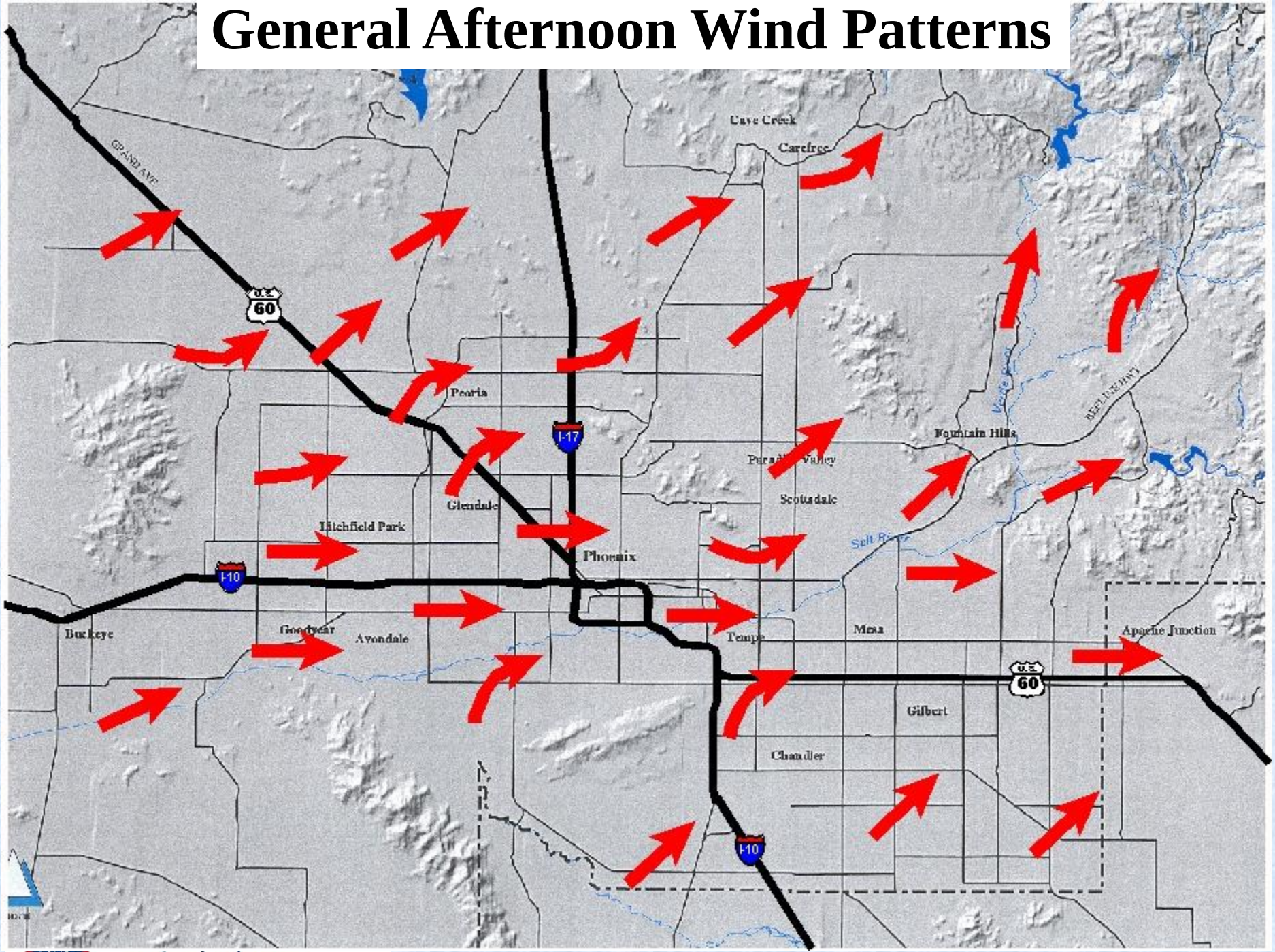
Under stagnant conditions, layers of air form, with cooler air near the ground and warmer air aloft. Pollution stays near the ground.



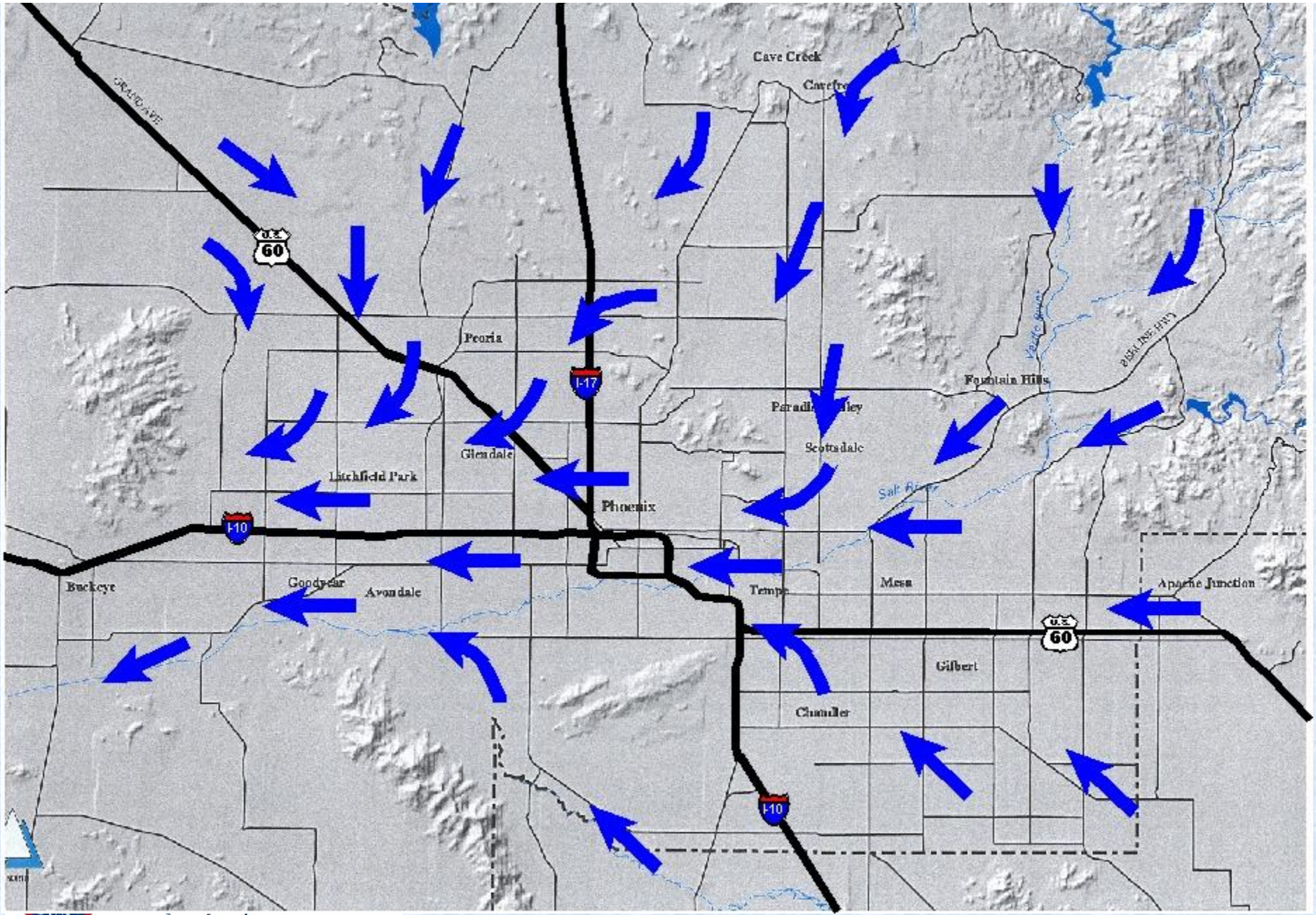
Topography

- Topography affects horizontal air movement during stagnant conditions.
  - Up-valley flow occurs after the inversion breaks up.
  - Down-valley flow, or cold air drainage occurs during the inversion conditions.
- The Valley is broad and shallow, which contributes to stagnation

General Afternoon Wind Patterns



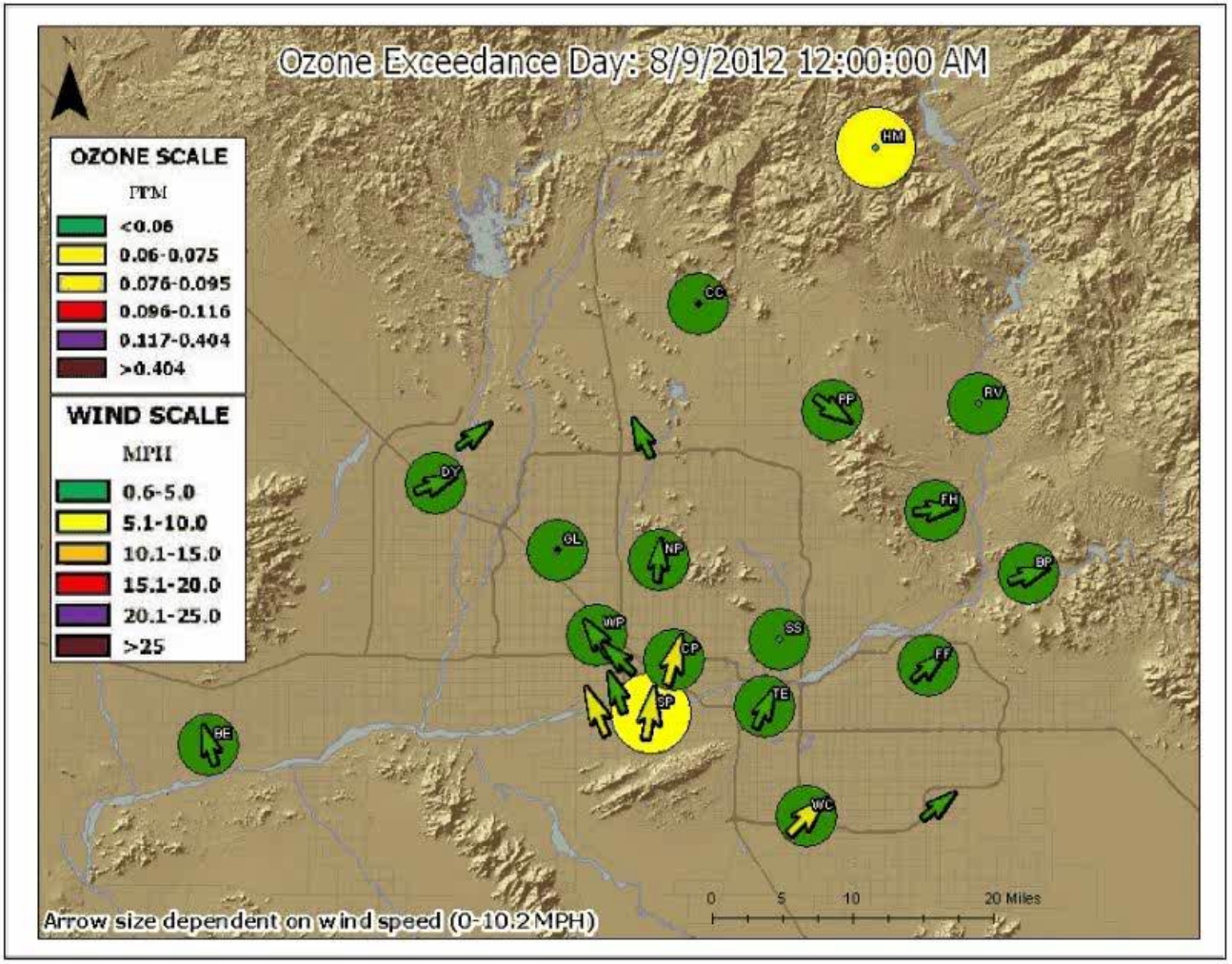
General Late Night/Early Morning Wind Patterns



Atmospheric Chemistry

- Most pollutant concentrations change due to dispersion
- Chemical reactions occur in the atmosphere
  - Ozone formation requires UV light, VOC and NOx
  - Secondary particles also form, including nitrate, sulfate, and organic particles
  - Aldehydes and other HAPs
  - Many reactions are reversible: ozone, nitrate and organic particles

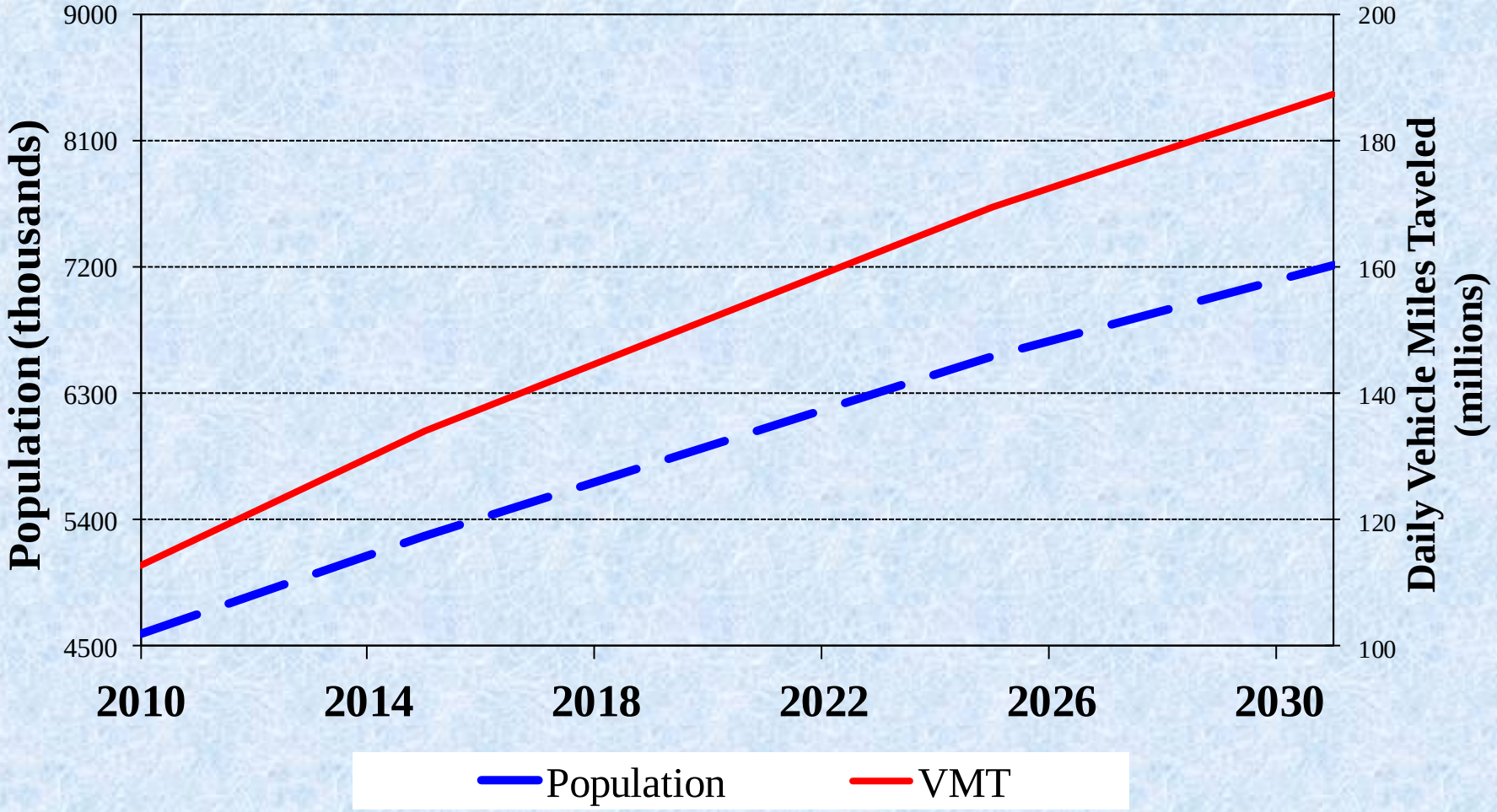
Ozone Formation Demonstrates Complex Physics and Chemistry



Other Considerations

- Weather cannot be controlled, but pollution emissions can
- Time of day emissions occur is important
- Growth in the Valley presents a challenge

MAG Population and VMT Projections
2010 - 2031



Source: 2010 MAG Conformity Analysis (July 2010)

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URBAN HAZE

Saturday, January 21, 2006 9:30am

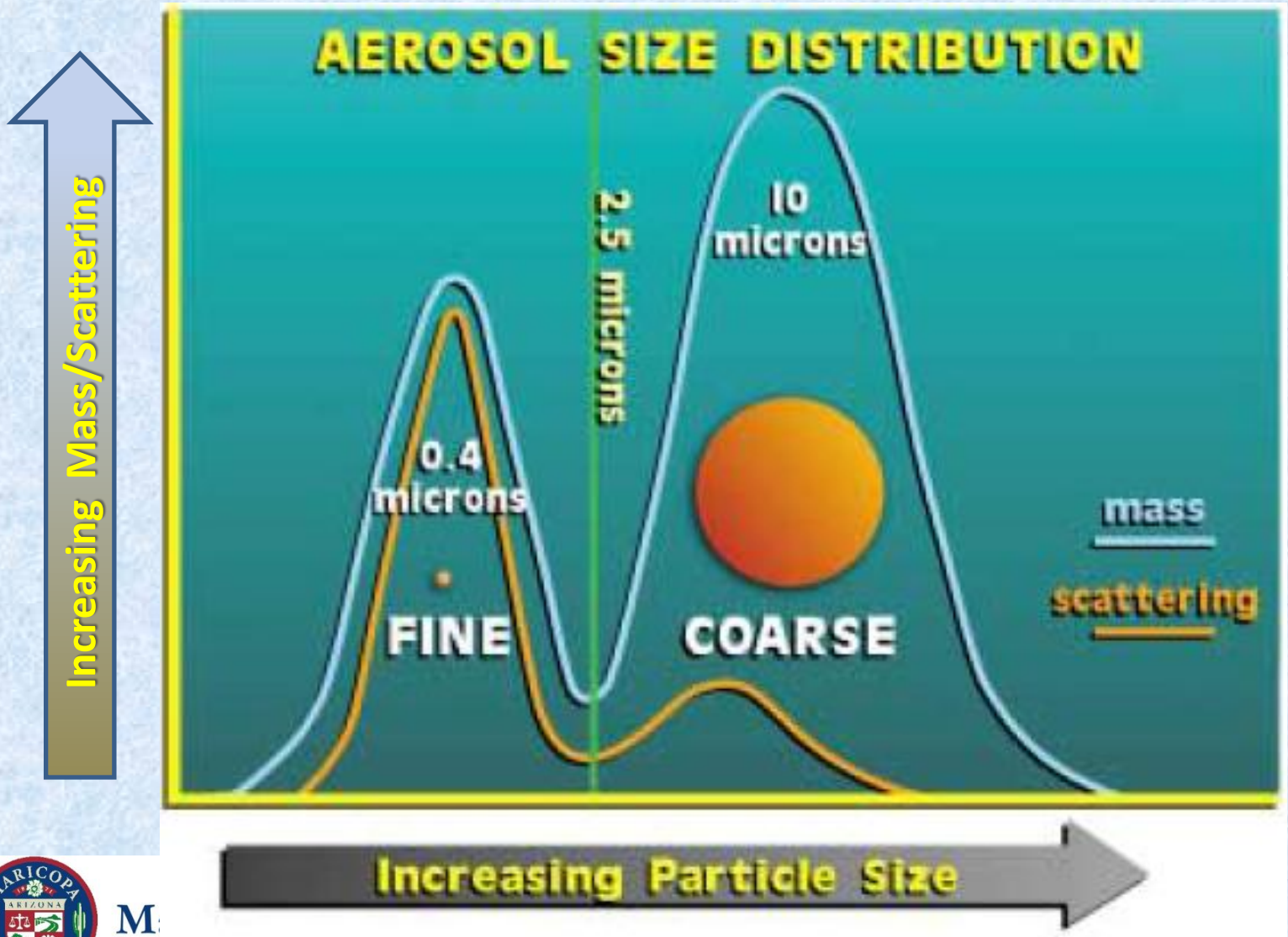
Max 24-hr $PM_{2.5}$ concentration was 25 µg/m^3

Worst daylight 4-hr average visual range was 12.6 miles

Visibility Impacts Complex

- Particle sizes and concentrations
- Humidity
- Chemical species
  - Black (elemental) carbon
  - Organic carbon, primary and secondary
  - Nitrate and sulfate (mostly secondary)
  - Fine soil
  - Coarse matter and sea salt
- Sun angle

Particle Size Affects Visibility Impact

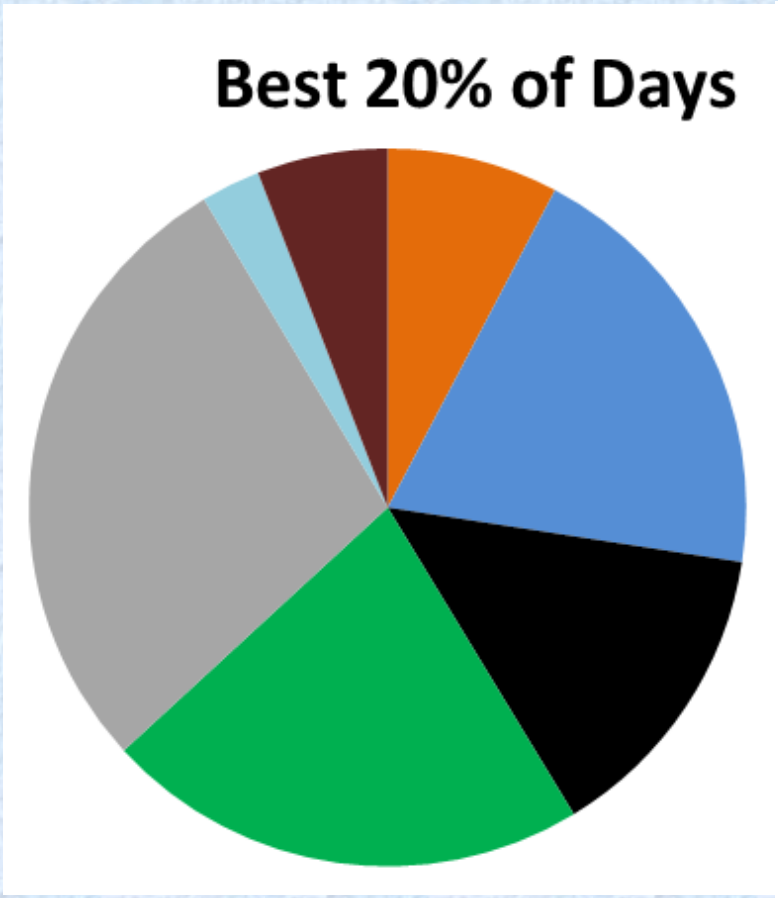


The Brown Cloud

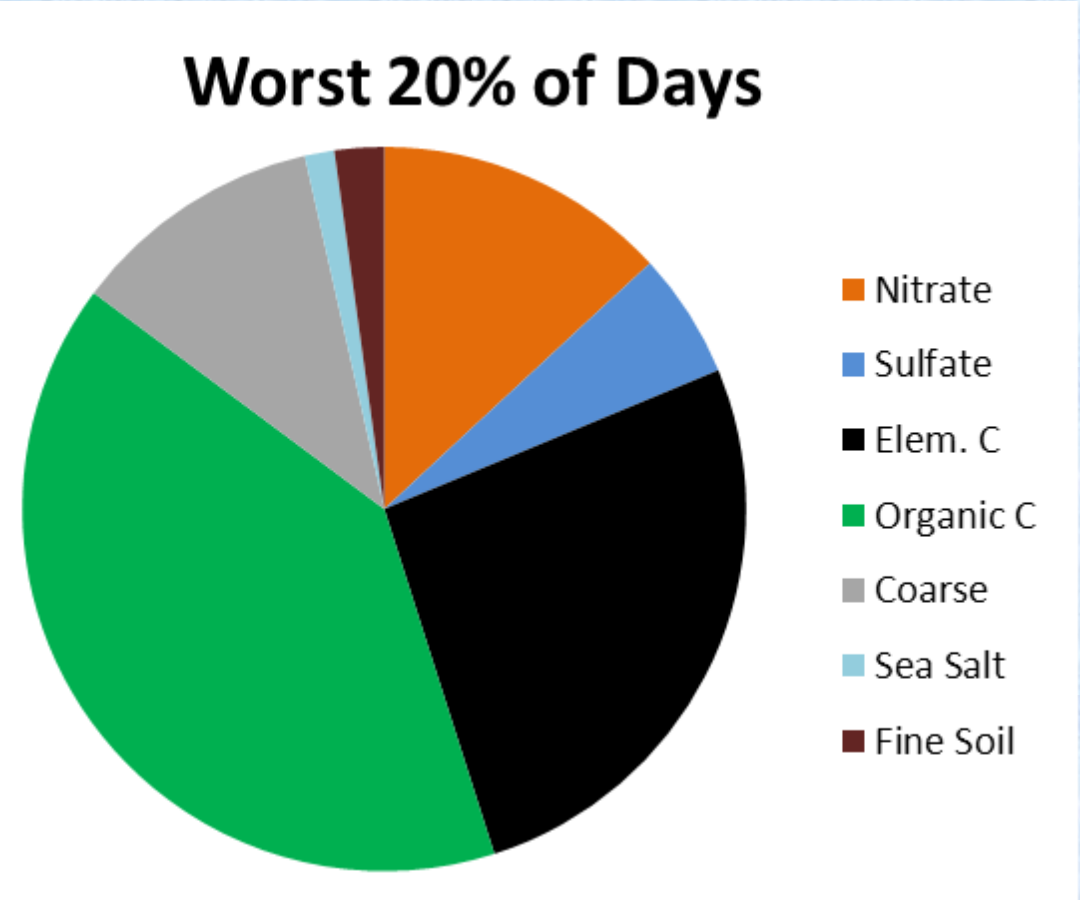
- Original research in 1989-1991
- Continuous monitoring since 1994
- Brown color is not dust, but carbon particles and to a lesser extent oxides of nitrogen
- Mobile sources, on- and off-road, are the primary contributors, on average
- Visibility Index

www.PhoenixVis.net

Pollutants in the Brown Cloud for 2010



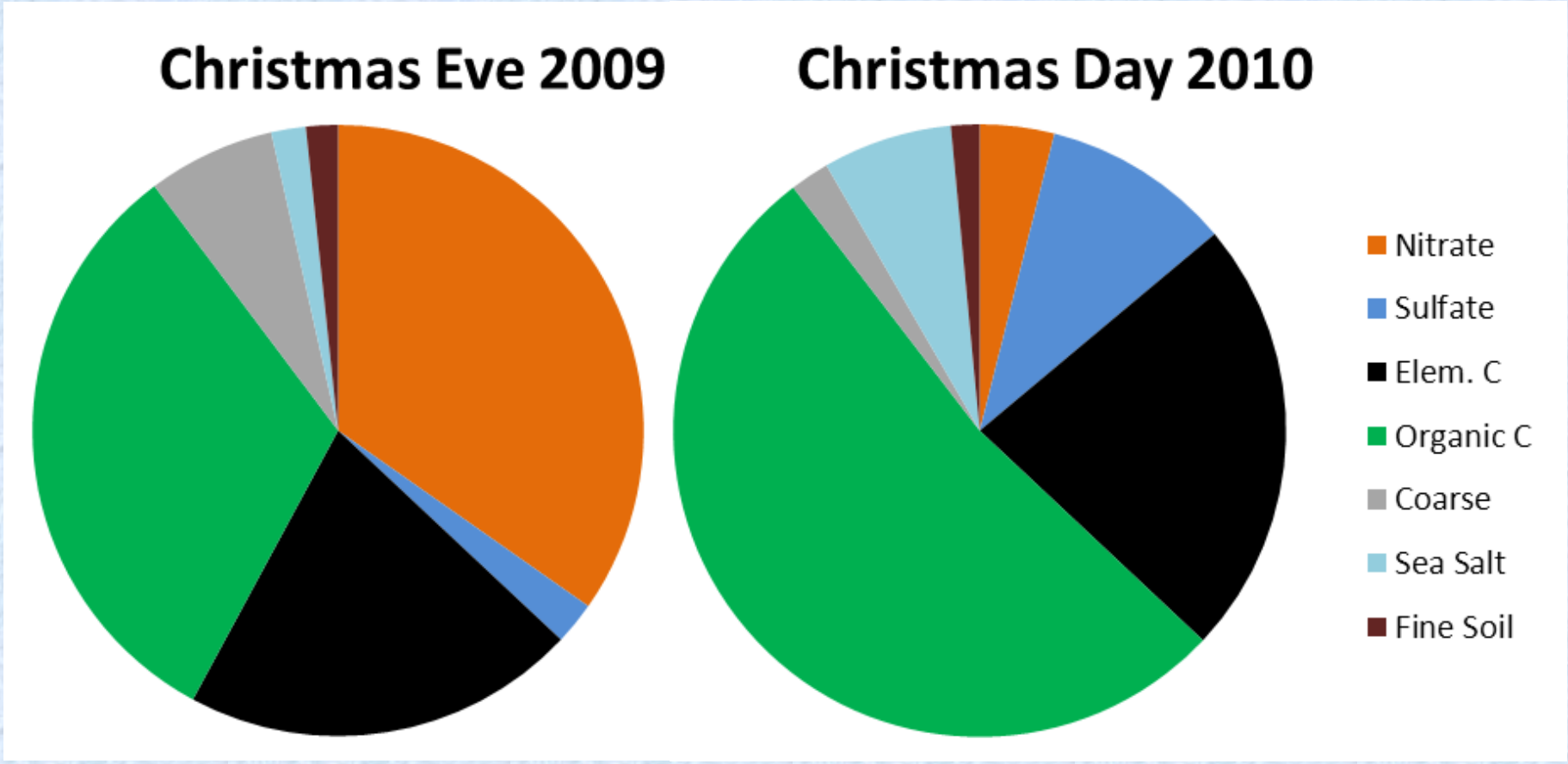
Visual Range – 133 miles*



Visual Range – 33 miles*

Data from JLG Supersite IMPROVE monitor
*Aerosol extinction only; excludes Rayleigh

Pollutants in the Brown Cloud, Holidays



Visual Range – 17 miles*

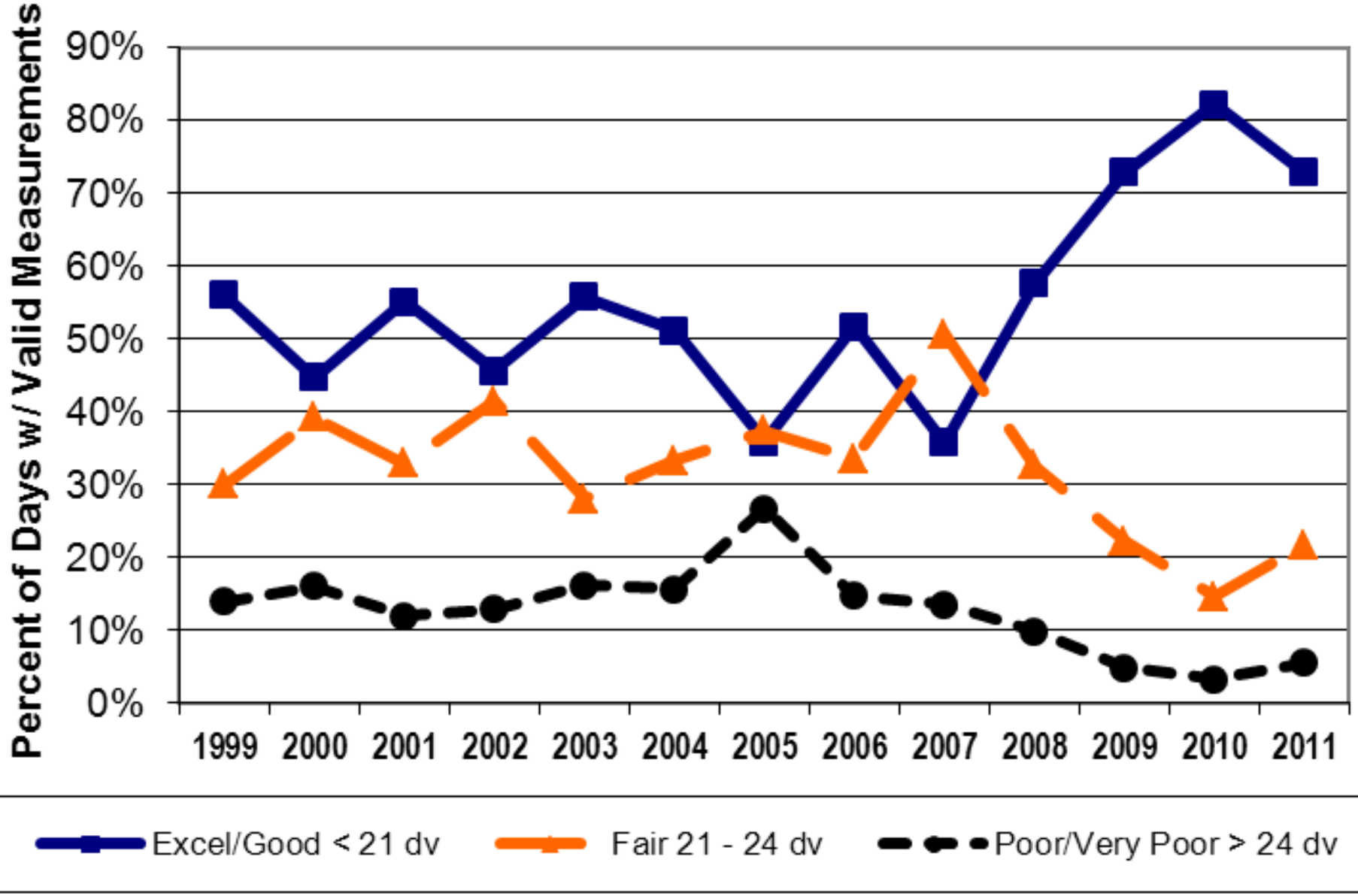
Visual Range – 22 miles*

Data from JLG Supersite IMPROVE monitor
*Aerosol extinction only; excludes Rayleigh

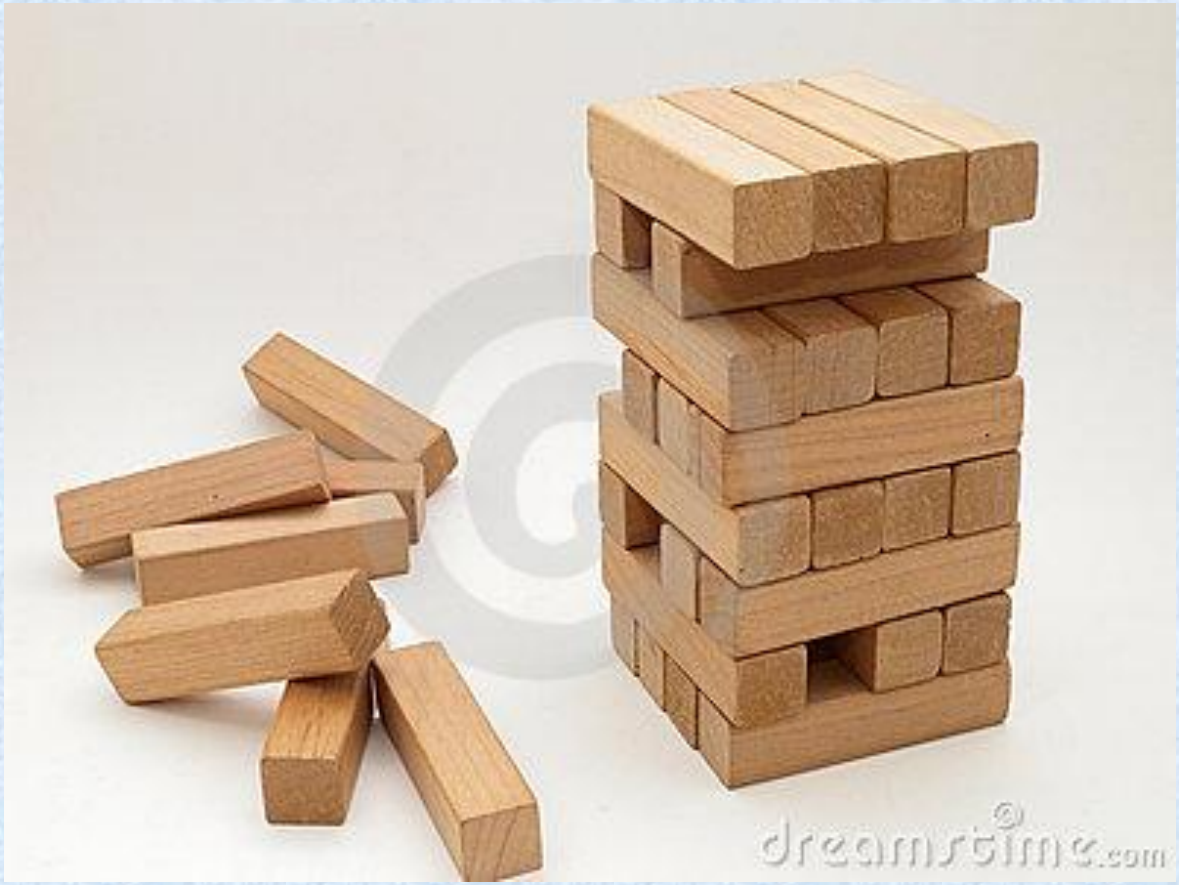
Phoenix Area Visibility Index

- Excellent< 15 dv
- Good 15 – 20 dv
- Fair 21 – 24 dv
- Poor 25 – 28 dv
- Very Poor > 28 dv

Phoenix Visiblity Index Trends
1999 - 2011



WHO DOES WHAT – JURISDICTION JENGA



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CLEAN AIR: MAKE MORE

Who are the Players?

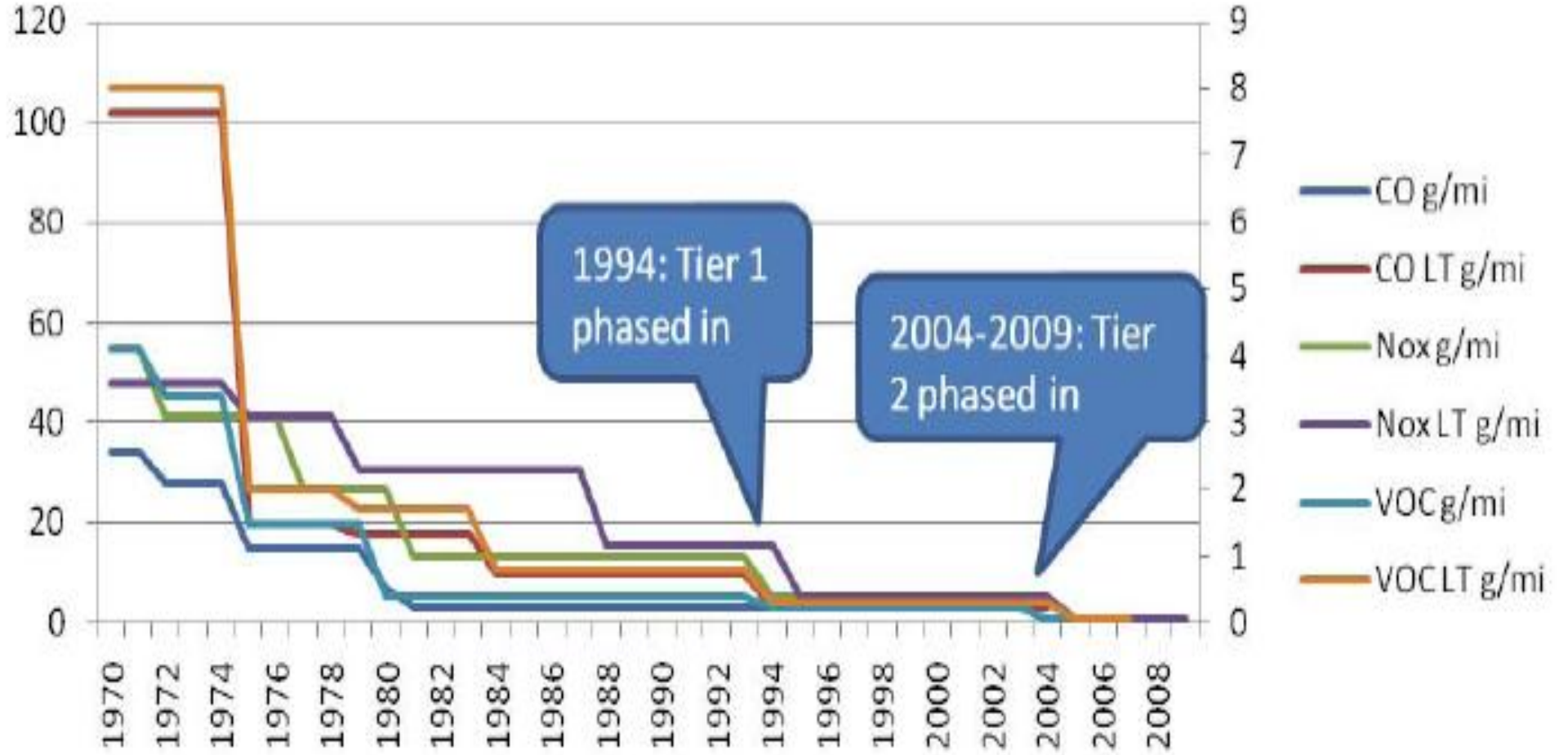
- Federal agencies, primarily EPA
- Native American tribes
- State of Arizona
- County air quality districts
- Regional planning agencies
- Cities and towns

Federal Government

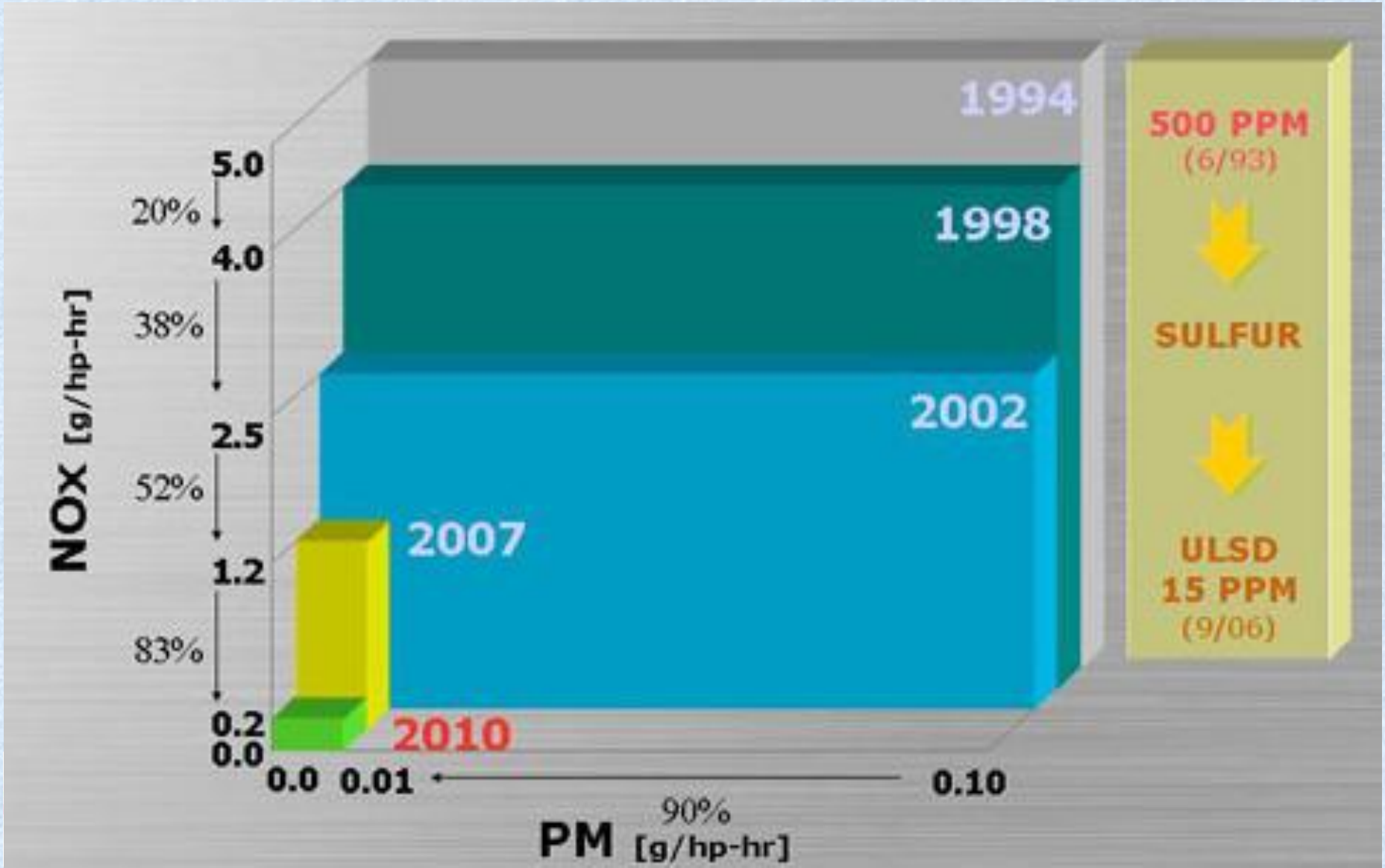
- U.S. Environmental Protection Agency
  - Sets national standards for:
    - Ambient air and monitoring
    - Major industrial facilities
    - Mobile sources and fuels
    - State and Local Programs, including tech. guidelines
  - Stratospheric Ozone - CFCs, etc.
  - Acid Rain
- Federal Land Managers – NPS, USFS, BLM, F&WS

EPA Vehicle Emission Regulations for Cars and Light Trucks (LT), grams/mile

(CO on the left axis, all others on the right axis)



EPA Heavy Duty Diesel Standards



Native American Nations

- Indian Tribes
  - 22 in Arizona
  - "Dependent" sovereign nations
  - Treated as states under CAA
  - Several in Arizona developing air quality programs
    - GRIC has an approved TIP

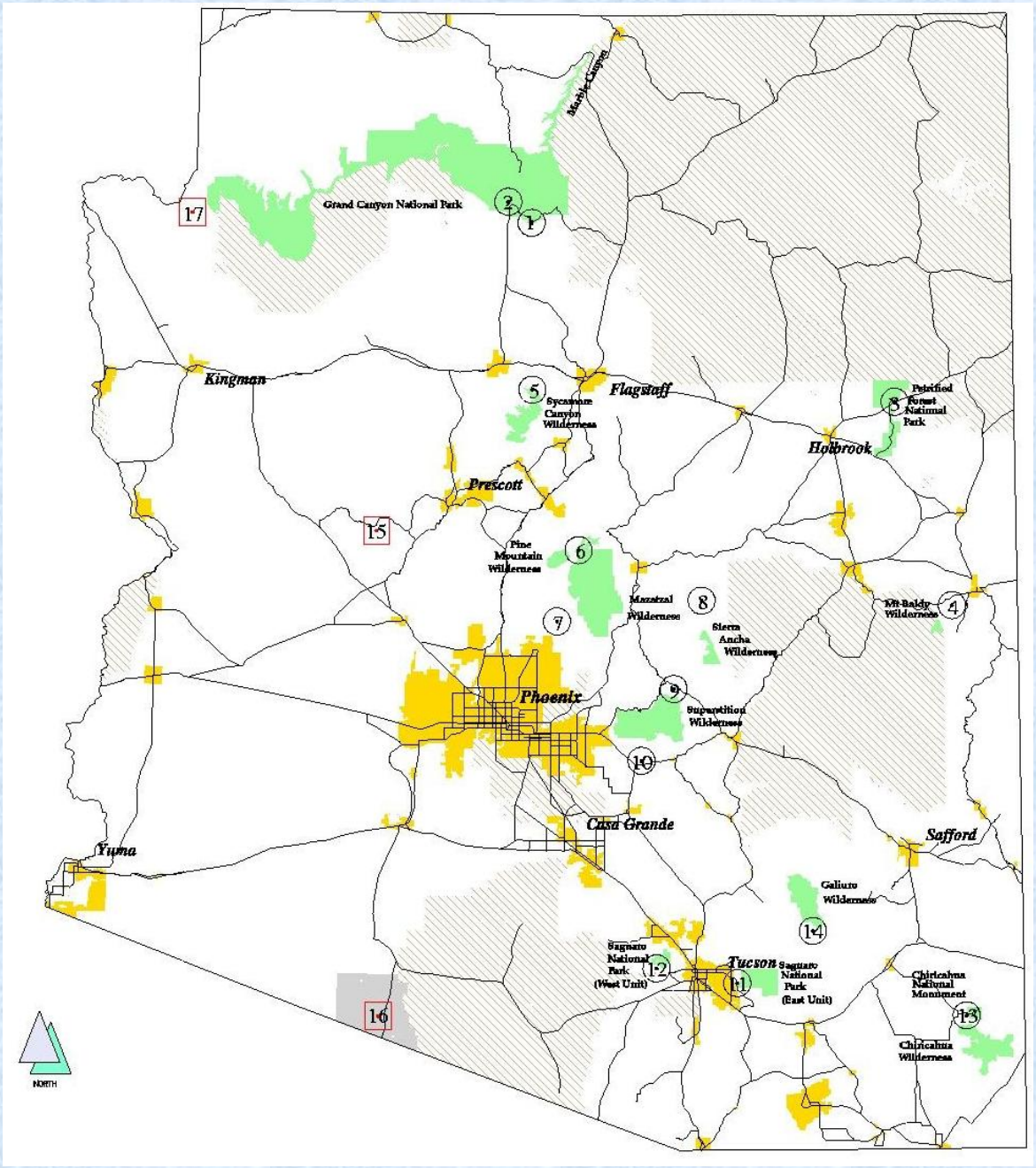
State of Arizona

- Arizona Department of Environmental Quality
  - Statewide air quality program
  - State Implementation Plan (SIP)
  - Mobile Sources - Vehicle Emissions Inspections
  - Very large stationary sources
  - Agricultural Best Management Practices
  - Air quality plans in non-metropolitan counties
  - Benchmark for county programs
  - Regional and urban haze
  - Open burning and prescribed burns
  - Other research

State Visibility Program

- 12 Mandatory Federal Class I Areas
- Stationary Source Controls
  - Prevention of Significant Deterioration
  - Best Available Retrofit Technology (BART)
- Regional Haze
  - Grand Canyon Visibility Transport Commission
  - Western Regional Air Partnership (WRAP) - www.wrapair2.org (www.wrapair.org for archived materials)

Arizona Class I Areas and Visibility Monitoring Network



1. Hance
2. Indian Garden
3. Petrified Forest
4. Greer Water Treatment Plant
5. Camp Raymond
6. Ike's Backbone
7. Humboldt Mountain
8. Pleasant Valley Ranger Station
9. Tonto National Monument
10. Queen Valley Water Tank
11. East Unit Research Center
12. West Unit Well Site
13. NM Entrance Station
14. Muleshoe Ranch
15. Hillside
16. Organ Pipe Cactus NM
17. Meadview

Federal Class 1 Areas
Arizona Cities
Organ Pipe Cactus NM
Indian Lands
Major Freeways
Class 1 Area Sites
Background Sites
17 Site Number

State of Arizona

- Arizona Department of Weights & Measures
  - Regulation of fuel quality:
    - Cleaner Burning Gasoline
    - Oxygenated Fuels
    - Diesel Fuel
  - Stage II Vapor Recovery

County Air Quality Districts

- County programs preceded the State program
  - Original jurisdiction over all but mobile, very large industrial sources, portables that operate in more than 1 county
- Maricopa, Pima and Pinal Counties
  - Ambient air monitoring
  - Stationary and “area” source regulation
    - Permits, inspections and enforcement
  - Residential wood smoke
  - Open burning
  - Travel reduction
  - Voluntary Vehicle Retrofit and Repair

Regional Agencies and Municipalities

- Maricopa and Pima Associations of Governments
  - Air quality plan development
  - Transportation planning
- Cities and Towns
  - Variety of specific control measures, e.g.,
    - Dust control for unpaved roads, parking areas, municipal operations
    - Alternative fuel fleets
    - Traffic signal synchronization

Public perception belies

THREE DECADES OF SIGNIFICANT AIR QUALITY IMPROVEMENTS

(mostly)

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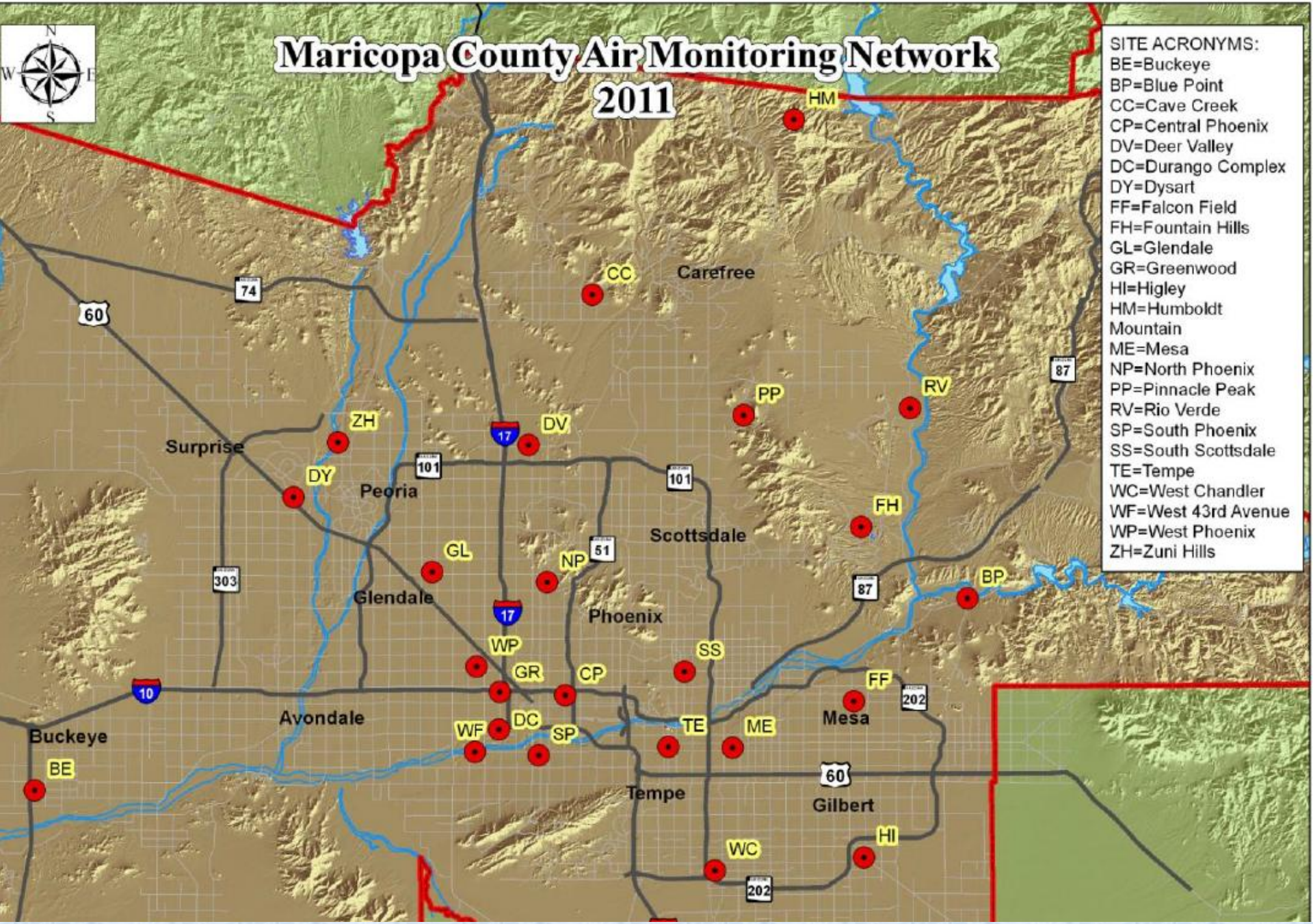
Maricopa County Air Monitoring Network
2011
SITE ACRONYMS:
BE=Buckeye
BP=Blue Point
CC=Cave Creek
CP=Central Phoenix
DV=Deer Valley
DC=Durango Complex
DY=Dysart
FF=Falcon Field
FH=Fountain Hills
GL=Glendale
GR=Greenwood
HI=Higley
HM=Humboldt Mountain
ME=Mesa
NP=North Phoenix
PP=Pinnacle Peak
RV=Rio Verde
SP=South Phoenix
SS=South Scottsdale
TE=Tempe
WC=West Chandler
WF=West 43rd Avenue
WP=West Phoenix
ZH=Zuni Hills
HM
CC
Carefree
PP
RV
ZH
DV
DY
Surprise
Peoria
Scottsdale
FH
GL
NP
BP
Glendale
Phoenix
WP
SS
GR
CP
FF
Mesa
Avondale
DC
WF
SP
TE
ME
Buckeye
BE
Tempe
Gilbert
HI
WC
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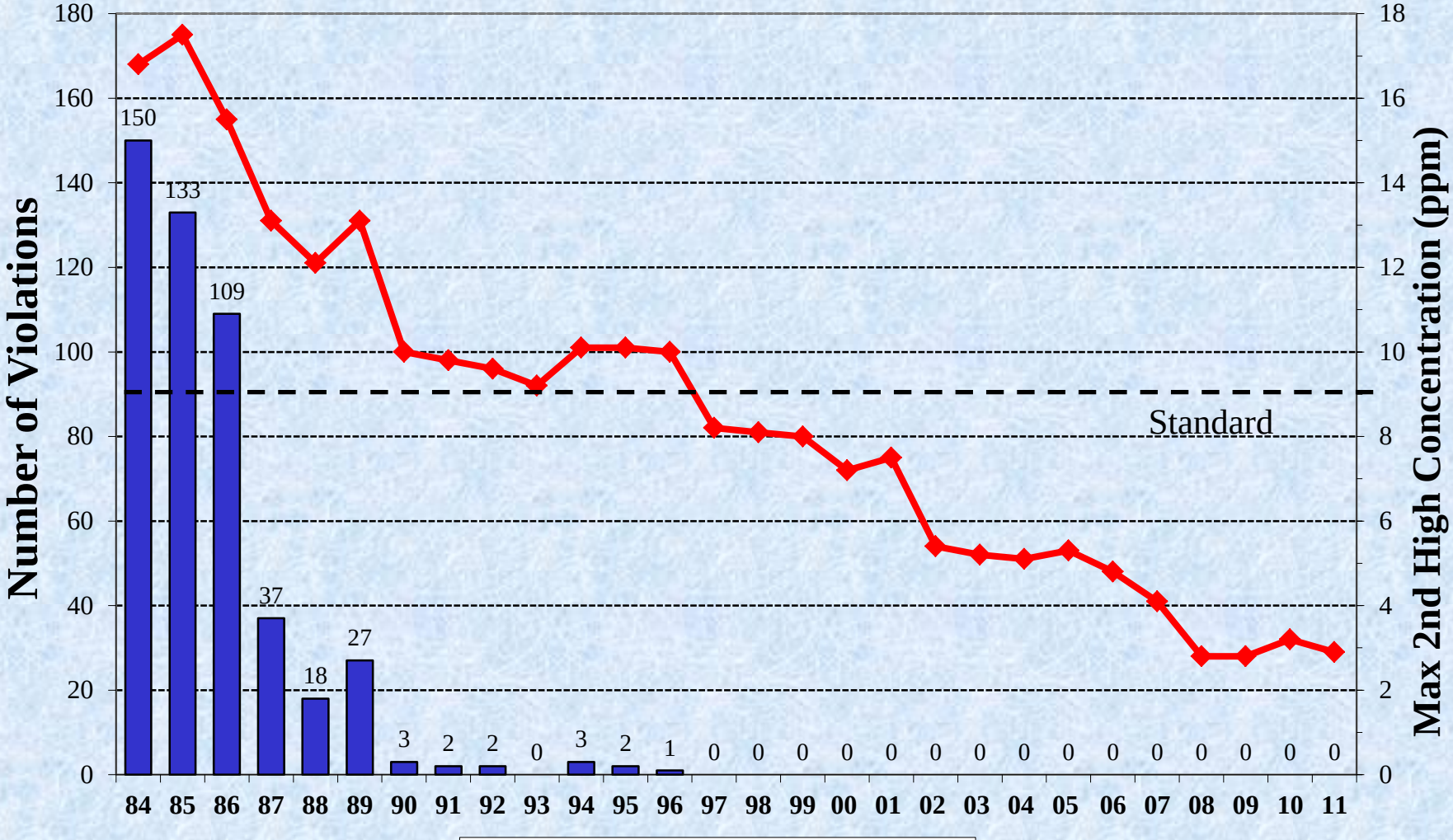
101
51
303
87
10
202

Carbon Monoxide Violations and Concentrations
Maricopa County, 1984 - 2011



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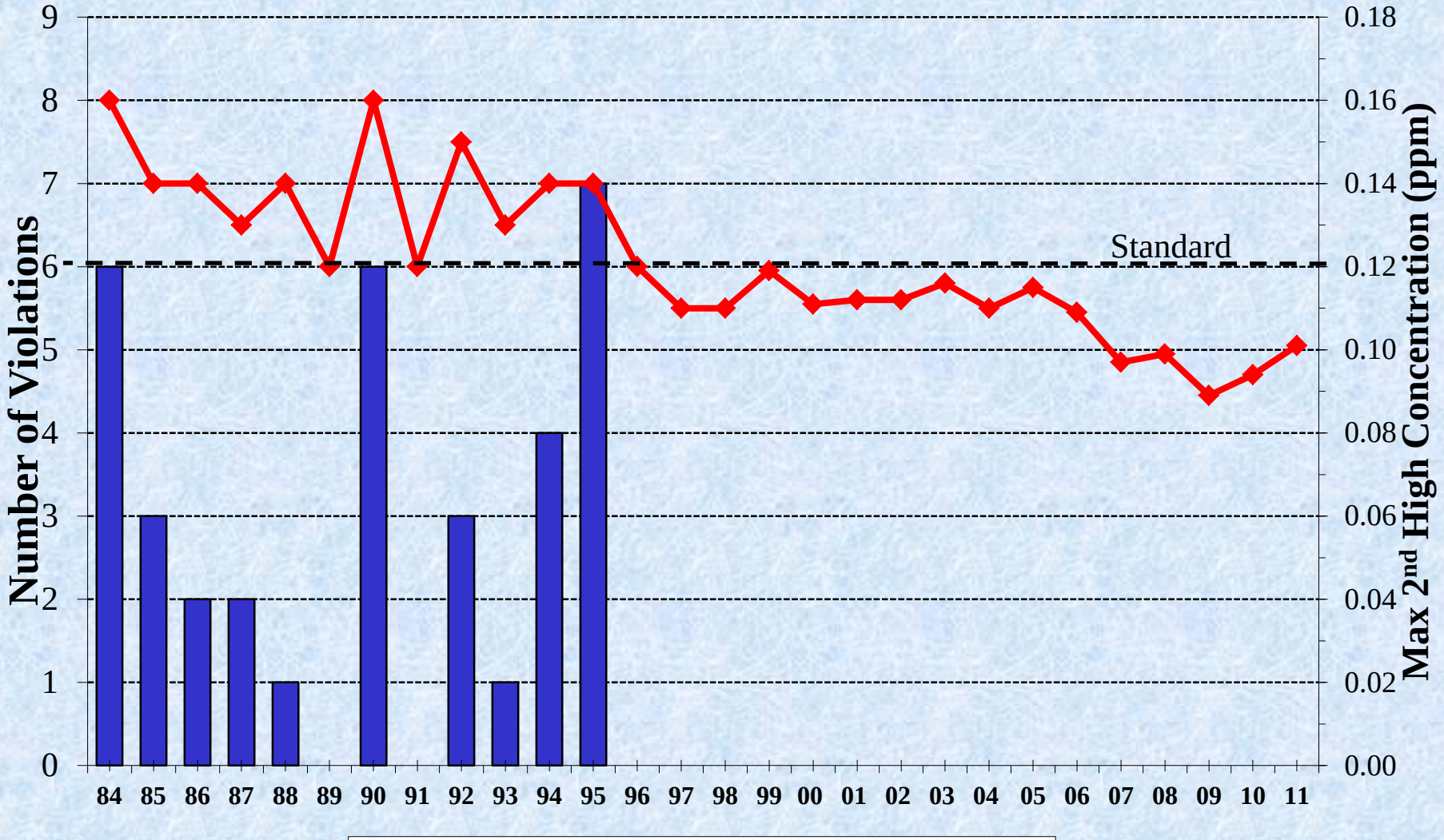
1-Hour Average Ozone Violations and Concentrations, Maricopa County, 1984 - 2011



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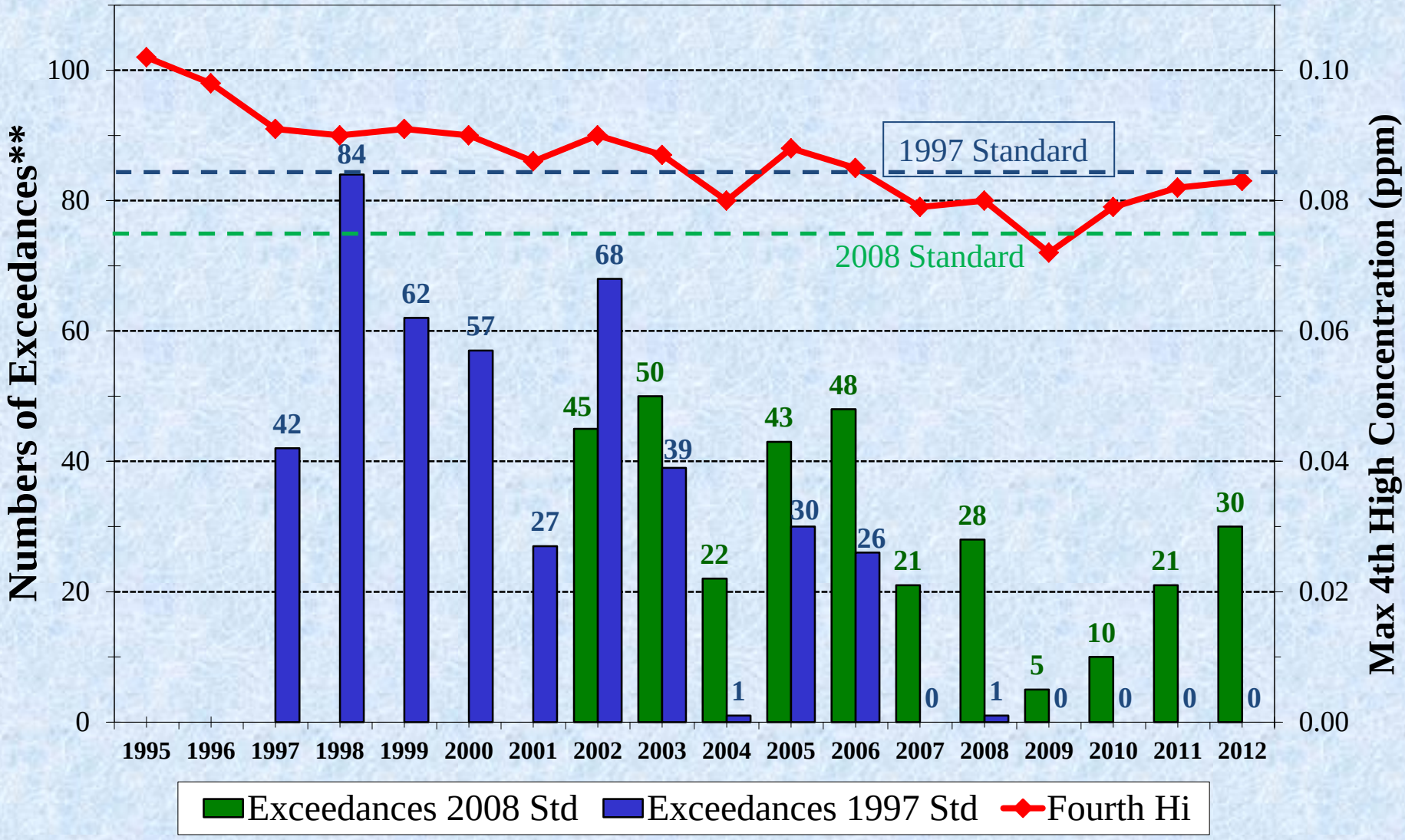
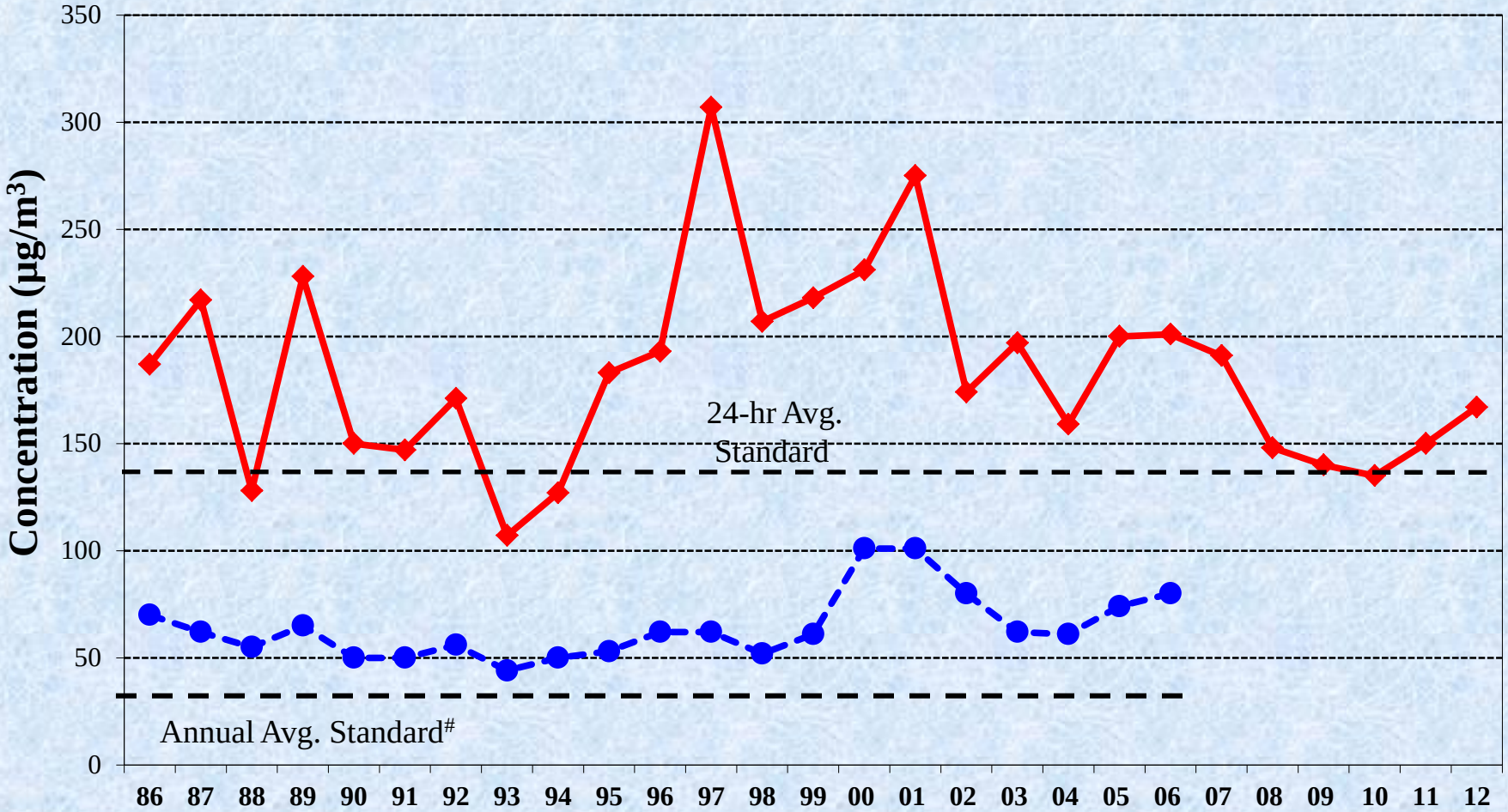
8-hour Average Ozone Exceedances and Concentrations
Phoenix Nonattainment Area, 1995 - 2012*



* Tribal monitors excluded; 2012 data are preliminary.

**1995 and 1996 exceedance count excluded because there were fewer monitors in the network than in subsequent years.

PM_{10} Concentrations
Maricopa County, 1986 - 2012*



*Tribal monitors excluded. Flagged exceptional events excluded from 2006 thru 2012.
2012 data are preliminary.

EPA repealed the annual average standard in 2006.

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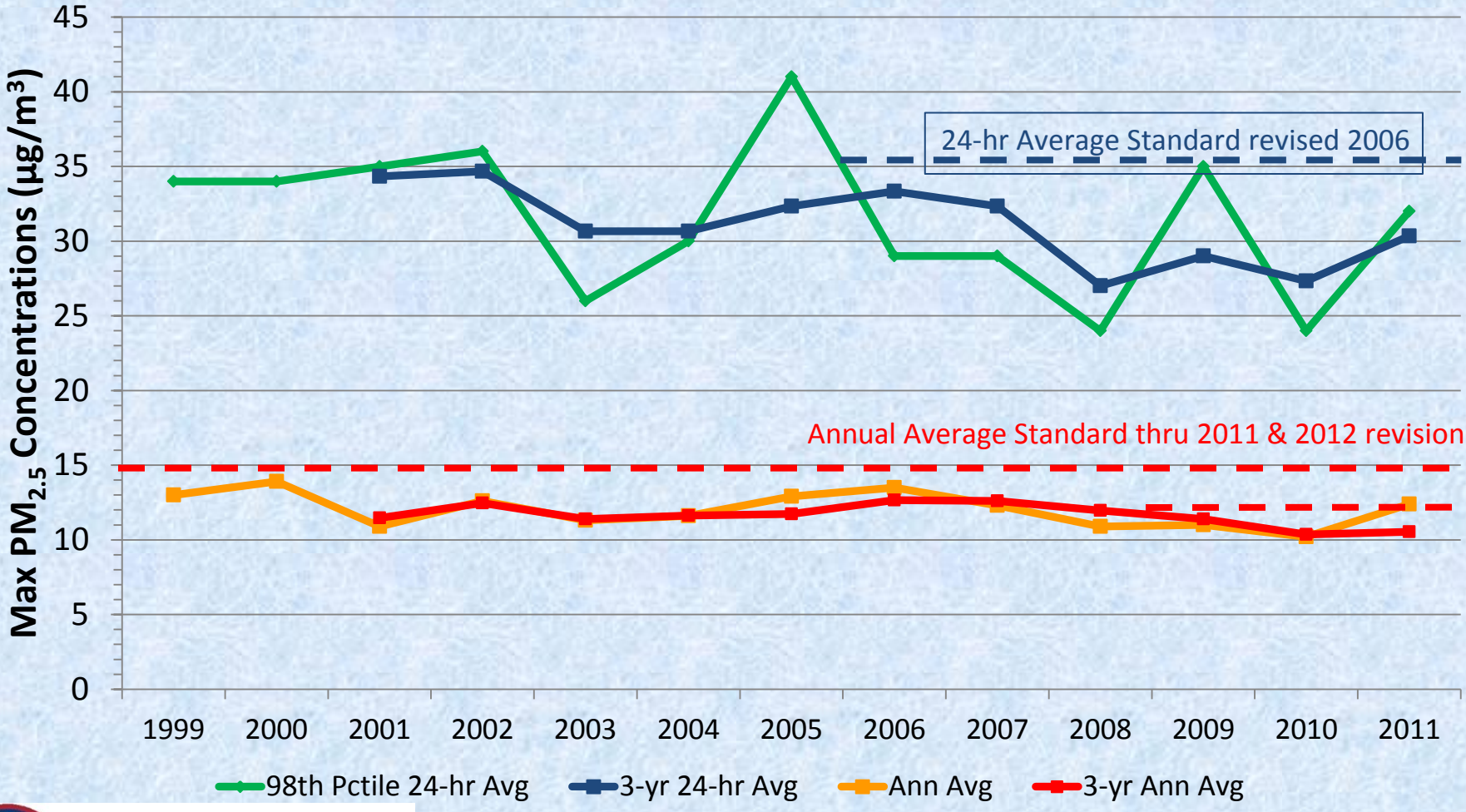
Maricopa County $PM_{2.5}$ Concentrations
1999 -2011



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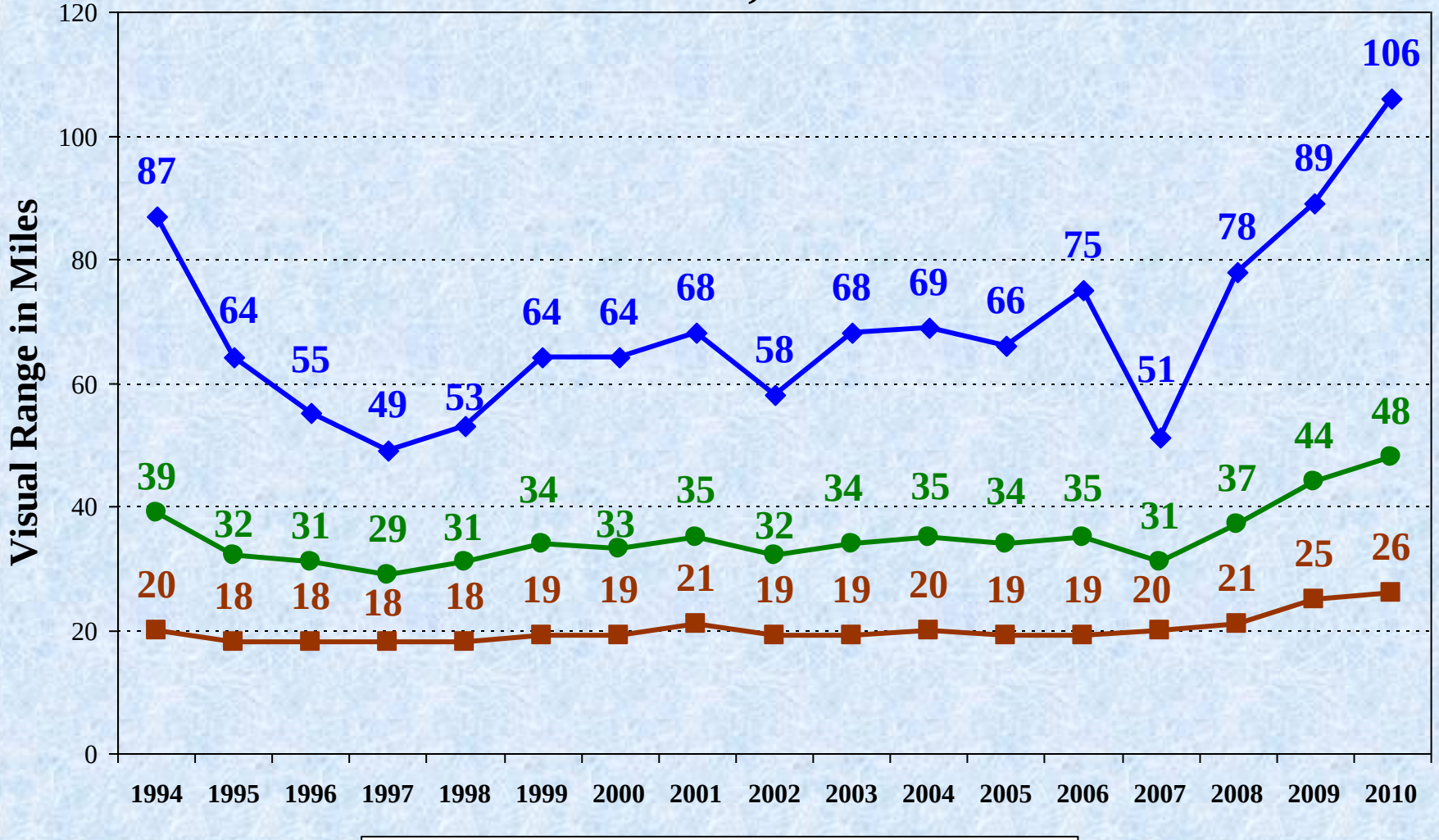
Trends in Visual Range

Central Phoenix, 1994 - 2010



Source: ADEQ Phoenix Transmissometer data.

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DEAR SCIENTISTS

you have 2 years